AN ADJUSTMENT LEVER FOR A TORSION BAR

BACKGROUND OF THE INVENTION

1. Related Application

[0001] The subject patent application claims priority to and all the benefits of the U.S. Provisional Patent Application Serial No. 60/465,254 filed on April 24, 2003.

2. Field of the Invention

[0002] The subject invention relates to a suspension assembly for an automotive vehicle, and more particularly to a torsion bar suspension system and an adjustment lever for adjusting the torsion in the torsion bar.

3. Description of the Prior Art

[0003] A torsion bar suspension system of the type having a suspension height adjusting mechanism is well known in the art and is widely used in an automotive industry today. Such a torsion bar suspension system includes a lower control arm having a typical A-frame construction that mounts the torsion bar at its legs and mounts upper and lower ball joints at its opposite end. A torsion bar adjustment arm, i.e. a lever, is mounted on the torsion bar and has an arm that extends radially from the torsion bar to engage an adjustment bolt carried on the vehicle frame to raise or lower the position of the adjustment arm. Adjusting the position of the adjustment arm has the effect of applying more or less torque on the torsion bar, which in turn raises or lowers the front of the vehicle.

[0004] Over time, the torsion bar has a tendency to relax or weaken, causing the front end of the vehicle to sag. When the vehicle is serviced, a technician can raise the front end a certain amount by raising the adjustment arm via the adjustment bolt. However,

in many cases, the torsion bar has relaxed beyond the range of adjustment of the arm, such that the vehicle can no longer be brought back into the original specification for alignments. Accordingly, the torsion bar must be replaced at considerable cost.

[0005] United States Patent Nos. 2,713,484 to Pierce, 3,432,158 to Goodwin, 4,223,227 to Kataoka, 4,863,348 to Hufnagel, 5,186,236 to Bollier, 6,374,297 to Weber, and 6,454,284 to Worman, Jr. show variety of mechanisms and suspension systems for adjusting the torsion in a torsion bar to adjust the height of the front end of the vehicle. Many of these prior art designs are complex, bulky in structure and require considerable space under the vehicle body to allow the operator to adjust the systems. Furthermore, at least some current designs require replacement of the relaxed torsion bar to restore a ride height due to insufficient adjustment travel in a production torsion bar adjustment lever.

[0006] A need exists for a suspension mechanism or system for adjusting the torsion in a torsion bar without replacing the torsion bar.

BRIEF SUMMARY OF INVENTION

[0007] The invention provides an improved adjustment lever for applying torsion to torsion bar for resisting movement of a control arm movable relative to the support frame in a vehicle. The adjustment lever further includes a torsion bar connection between the adjustment lever and the torsion bar for connecting the adjustment lever to a torsion bar at a plurality of primary drive positions at first angular increments relative to one another. The assembly includes an indexing system for positioning the adjustment lever at a plurality of intermediate drive positions at second angular increments.

[0008] An advantage of the present invention is to provide a two-piece adjustment lever for a torsion bar featuring an asymmetric spline arrangement within a fixed hex interface allowing for the torsion bar preload in a plurality of intermediate drive positions other than the first angular increments relative to the torsion bar at angular increments less than the degree increments in the hex interface. As a result, the torsion bar need not be replaced as its range of torsion is significantly increased.

[0009] Another advantage of the present invention is to provide the two-piece adjustable lever, which allows to increase or decrease in the ride height per owner preference, thereby increasing road clearance or providing custom vehicle appearance.

[0010] Still another advantage of the present invention is to provide the two-piece adjustable lever, which allows adjustment of the ride height to factory specification after the addition of vehicle accessories increases the sprung weight of the vehicle.

[0011] Still another advantage of the present invention is to provide the two-piece adjustment lever that is easily removed and calibrated to compensate for added load to the front of the vehicle and to compensate the torsion bar sag or fatigue.

[0012] The use of the present invention may allow maintenance of factory ride height to production specification for the life of the vehicle, without the necessity of replacing the torsion bar.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0014] Figures 1 is a side view of a prior art adjustment lever and a torsion bar assembly design;

[0015] Figures 2 is an exploded view of a suspension assembly for an automotive vehicle including a first embodiment of an adjustment lever and a hub of the present invention;

[0016] Figure 3 is a perspective and exploded view of the adjustment lever and the hub shown in Figure 2;

[0017] Figure 4 is a front side view of the adjustment lever and hub shown in Figure 3;

[0018] Figure 5 is a perspective view of a first alternative embodiment of the adjustment lever of the present invention;

[0019] Figure 6 is a side view of a second alternative embodiment of the adjustment lever of the present invention;

[0020] Figure 7 is a cross sectional view taken along line 7-7 of Figure 6;

[0021] Figure 8 is a side view of a third alternative embodiment of the adjustment lever of the present invention;

[0022] Figures 9 is a side view of a fourth alternative embodiment of the adjustment lever of the present invention;

[0023] Figure 10 is a side view of a fifth alternative embodiment of the adjustment lever of the present invention; and

[0024] Figure 11 is a side view of a sixth alternative embodiment of the adjustment lever of the present invention; and

[0025] Figure 12 is a schematic view illustrating the increments of adjustment of the embodiment of Figures 2-4.

DETAILED DESCRIPTION OF THE INVENTION

[0026] An adjustment lever assembly of the prior art is generally shown at **20** in Figure 1. The prior art adjustment lever assembly **20** includes an adjustment lever **22** connected to a torsion bar **24.** The adjustment lever **22** has an arm **26** that extends radially from the torsion bar **24** to be engaged by an adjustment bolt **28.** The bolt **28** is carried on a vehicle frame **30** to raise or lower the position of the adjustment lever **22,** i.e., pivot the lever **22** about the axis of the torsion bar **24.** Over time, the torsion bar **24** has a tendency to relax, i.e., fatigue and loose torsional strength, thereby causing the front end of the vehicle (not shown) to sag. In many cases, the torsion bar **24** relaxes beyond the range of adjustment of the adjustment lever **22,** such that the vehicle can no longer be brought back into original specification for alignments. In this case the torsion bar **24** must be replaced at considerable cost.

[0027] Referring to Figure 2, an automobile vehicle suspension assembly is generally shown at **40.** The assembly **40** includes a support frame **42** and a control arm **44** movable relative to the support frame **42.** A torsion bar **46** has a hexagonal head **48** at each end and is connected to the control arm **44** for resisting movement of the control arm **44.**

[0028] An adjustment lever, generally shown at **50** in Figures 2 through 4, is connected to the torsion bar **46** and is designed for placing the torsion bar **46** in torsion. The adjustment lever **50** includes a pivot portion **54** of generally rounded shape, a tip portion **56,** and a central or lever portion **58,** extending therebetween. The tip portion **56** includes at least one indentation **60** defined therein and an adjusting mechanism, generally shown at **62**

in Figure 2, is connected to the support frame **42** for engaging the indentation **60** and pivoting the adjustment lever **50** to increase the amount of torsion in the torsion bar **46**. The pivot portion **54** includes the hexagonal pocket or socket, generally indicated at **64**, with a plurality of tooth cavities **66** of a generally rectangular configuration extending therein. The tooth cavities **66** further include rounded corners **68**.

[0029] The present invention also includes a torsion bar connection that is positioned between the adjustment lever **50** and the torsion bar **46** for connecting the adjustment lever **50** to the torsion bar **46** at a plurality of primary drive positions at first angular increments relative to one another. The assembly **40** of the present invention further includes an indexing system, generally shown at **70** in Figures 3 and 4 for positioning the adjustment lever **50** at a plurality of intermediate drive positions at second angular increments.

[0030] The indexing system **70** includes a hub **74** independent of and removably invertible relative to the pocket **64** in the adjustment lever **50.** The hub **74** includes two opposite sides, generally indicated at **76** and **78**, respectively, that are interconnected by inner **80** and outer **82** surfaces or peripheries. The inner surface **80** of the hub **74** defines a hexagonal socket to receive the hexagonal head **48** of the torsion bar **46** forming the torsion bar connection through which the hub **74** is connected to the torsion bar **46** at the first angular increments. The outer surface or periphery **82** of the hub **74** includes seven teeth **84** extending radially outwardly from the outer surface **82**. Each teeth **84** presents a generally rectangular configuration and includes rounded corners **86** that conform to and are complementary to the rounded corners **68** of the tooth cavities **66** in the pocket **64** of the adjustment lever **50**. The teeth **84** enable the hub **74** to be positioned angularly with

respect to the tooth cavities **66** of the hexagonal socket **64** in any of the plurality of intermediate drive positions other than the plurality of primary drive positions.

[0031] As shown in Figure 4, a tooth numbered **2** presents a center or zero radial line defining a secondary radial extending through the center of the tooth. However, the adjacent apex or corner of the hexagon of the inner socket **80** of the hub **74** defines a primary radial. The primary and secondary radials are offset from one another by an offset angle. The hexagonal socket **64** in the adjustment lever **50** receives the hub **74** but the hub **74** is removable from the hexagonal socket **64** for being inverted **180** degrees about the secondary radial, i.e., the central axis of one of the teeth connecting the hub **74** to the adjustment lever **50**. The hub **74** is then reinserted into the hexagonal socket **64** to position the primary radial relative to the secondary radial, e.g., on the opposite angular side of the secondary radial in Figures 2-4, whereby the angular position of the adjustment lever **50** may be adjusted by multiples of the offset angle.

[0032] In the embodiment of Figures 2-4, the second angular increments are equal to one another and the offset angle equals one fourth the difference between the first and second increments. Each of the first increments is defined by the sixth sided hexagon and equals 60 degrees whereas the second increments are defined by seven teeth and equals 51.428 degrees. The difference between the first increments defined by the hexagonal socket **64** having the six corners and the second increments defined by the seven teeth **84** equals 8.57 degrees. One half of 8.57 degrees is 4.28 degrees. Accordingly, to obtain 4.28 degrees of adjustment, the offset is one half of that as one fourth of 8.57 degrees, i.e., an offset of 2.14 degrees. When the hub is removed and flipped the adjustment is twice the offset of 2.14 degrees or 4.28 degrees. This is illustrated in Figure 12.

[0033] The adjustment of the lever **50** relative to the torsion bar **46** ranges from + 32.14 degrees to – 23.57 degrees from starting point of rotation of the hub **74** relative to the adjustment lever **50** by adding and subtracting the offset of 2.14 degrees defined between the primary and secondary radials of rotation of the hub **74** relative to the adjustment lever **50**. The table shown further below illustrates various adjustment ranges of the hub **74** relative to the adjustment lever **50** as the hub **74** is removed, inverted and reinstalled into the hexagonal socket **64** in the adjustment lever **50**, wherein A indicated one of the opposite sides **76** of the hub **74** and B indicates the other of the opposite sides **78** of the hub **74**, and numbers 1 through 7 indicate the aforementioned prime drive positions.

A1 -15.00 degrees	B1 - 2.14 degrees
A2 - 6.43 degrees	B2 + 6.43 degrees
A3 + 2.14 degrees	B3 + 15.0 degrees
A4 + 10.71 degrees	B4 + 23.57 degrees
A5 + 19.29 degrees	B5 + 32.14 degrees
A6 + 27.86 degrees	B6 - 27.86 degrees
A7 – 23.57 degrees	B7 -10.71 degrees

[0034] In this way, a technician (not shown) can determine to what degree the front end of the vehicle needs to be raised and can then orient the hub **74** in the arm portion **54** to effectively position the hub **74** in angular adjustment less than that provided by the hexagonal socket **64**. This embodiment eliminates a need of replacement an overly relaxed torsion bar **46** or modification the front suspension system and contributed to sufficient adjustment travel of the adjustment lever **50** relative to the torsion bar **46** and the support frame **42**.

[0035] Figure 5 shows a first alternative embodiment of the present invention, wherein like reference numerals are used to indicate like features with regard to the main embodiment but are offset by **100**. The adjustment lever **150** includes the pivot portion **154** having the circular socket **164** with the plurality of rounded tooth cavities **166** defined therein. The indexing system of the first alternative embodiment is generally shown at **170** and includes the hub **174** to be disposed in the adjustment lever **150**. The hub **174** is independent of and removably invertible relative to the aforementioned adjustment lever **150.** The plurality of rounded tooth cavities **166** are disposed on different radials than the first angular increments between the hub **174** and the adjustment lever **150**. The rounded tooth cavities **166** are grouped in a variety of selected positions covering a different setting range. In other words, an asymmetric spline arrangement within fixed interface allows 3 degree torsion bar preload increments ranging from –12 degrees to +21 degrees. The rounded tooth cavities **166** are adjacent one another in one group wherein each of the groups are spaced from one another. For example, one of the groups of the tooth cavities **166** may include two of the rounded tooth cavities **166**, adjacent one another, followed by another group that includes three of the rounded tooth cavities **166**, followed by a third group that includes four rounded tooth cavities **166**.

[0036] The hub **174** of the first alternative embodiment, as shown in Figure 5, includes the inner surface or socket **180** having a hexagonal configuration for receiving the hexagonal head **48** of the torsion bar **46**, and the outer surface or periphery **182** having a circular configuration. The outer periphery **182** of the hub **174** includes at least one tooth **184** extending outwardly from the outer surface **182**. In this embodiment, the tooth **184** has a rounded configuration to complement with the rounded configuration of the tooth cavities

166. Each tooth **184** is spaced diametrically opposite to one another around the outer periphery **182** of the hub **174**. The teeth **184** enable the hub **174** to be positioned angularly with respect to the rounded tooth cavities **166** extending inwardly into the circular socket **164** in any of the number of the selected positions.

[0037] Figures 6 and 7 show a second alternative embodiment of the present invention wherein like reference numerals are offset by **200**. The adjustment lever is generally shown at **250** and includes the pivot portion **254** having the circular socket **264** defined therein. The circular socket **264** presents a radially extending tooth cavity **266** of a generally rectangular shape. An adjustment device, generally shown at **268** of the indexing system **270** facilitates an interaction between the adjustment lever **250** and a hub **274** for adjusting the angular position of the hub **274** relative to the adjustment lever **250** through an infinite number of the intermediate drive positions. The adjustment device **268** includes a bore **271** defined in the arm portion **254** extending inwardly from the adjustment lever **250** to the tooth cavity **266**. The bore **270** is threaded to receive a screw **272** extending therethrough to engage the tooth **276** and to adjust the angular position of the hub **274** within the circular socket **264**. The tooth **276** is integral with and extends radially outwardly from the hub **274**. The tooth **276** of the hub **274** includes an indentation **278** designed to mate and react with the screw **272** in order to adjust the rotational position of the tooth **276** within the tooth cavity **266**. The tooth cavity **266** has a greater angular space than the angular width of the tooth **276** to allow the tooth **276** to move angularly within the tooth cavity **266**. The hexagonal socket **280** of the hub **274** receives the hexagonal head **48** of the torsion bar **46**.

[0038] Figure 8 shows a third alternative embodiment of the present invention similar wherein like reference numerals are offset by **300**. The adjustment lever is

generally shown at **350** and includes the pivot portion **354** and the circular socket **364**, defined therein, with several rounded tooth cavities **366** extending therein and being angularly spaced 120 degrees from one another. The teeth cavities **366** set a range between −12 degrees to between about +21 degrees. The indexing system of the third alternative embodiment is generally shown at **370** and includes the hub **374** disposed in the adjustment lever **350**. The hub **374** is independent of and removably invertible relative to the aforementioned adjustment lever **350**. The hub **374** of the third alternative embodiment cooperates with the circular socket **364** of the pivot portion **354** and includes the inner surface or socket **380** having a hexagonal configuration for receiving the hexagonal head **48** of the torsion bar **46** and the outer periphery **386** of a circular configuration to mate with the circular socket **354**. The outer surface **386** of the hub **374** includes the plurality of teeth **388** extending radially outwardly from the outer surface **386** to mate with the tooth cavities **372**. The teeth **388** are disposed 120 degrees from one another to enable the hub **374** to be positioned angularly with respect to the circular socket **354** in any of the number of the selected positions. As alluded to above, the hub **374** may be removed and flipped about the secondary radial defined by one of the tooth **366** so that the primary radial defined by one of the apexes of the hexagonal socket **380** is disposed on the opposite singular side of the secondary radial, both shown in phantom. As shown it full lines in Figure 8, the offset from the secondary radial extending centrally through a tooth **388** is offset from the primary radial extending through an axex of the hexagonal socket **380** by a greater angle with the primary and secondary radials on opposite sides of the X axis. In any case, the offset is from the centerline of one of the teeth interconnecting the hub and the adjustment lever. In this

embodiment, the tooth **388** has a rounded configuration to complement with the tooth cavities **366**.

[0039] Figure 9 shows a fourth alternative embodiment of the present invention similar to that of Figure 5, and wherein like reference numerals are offset by **400**. The adjustment lever is generally shown at **450** includes the pivot portion **454** and the circular socket **464** with the plurality of rounded tooth cavities **466** extending therein about the entire circumference of the circular socket **464**. The indexing system of the fourth alternative embodiment is generally shown at **470** and includes the hub **474** disposed in the adjustment lever **450**. The hub **474** is independent of and removably invertible relative to the aforementioned adjustment lever **450.** The hub **474** cooperates with the circular socket **464** of the arm portion **454**. The hub **474** includes the inner surface or socket **480** having a hexagonal configuration for receiving the hexagonal head **48** of the torsion bar **46** and the outer surface or periphery **476**. The outer periphery **476** includes a plurality of teeth **478** adjacent one another and extending radially outwardly from the outer surface **476** about the entire circumference of the outer surface **476**. The teeth **478** and the tooth cavities **466** enable the hub **474** to be positioned angularly in any of the number of the selected positions. In this embodiment, each tooth **478** includes a rounded configuration to mate with the tooth cavity **466**.

[0040] Figures 10 shows a fifth alternative embodiment of the present invention similar to that of Figures 5 and 9, and wherein like reference numerals are offset by **500**. The adjustment lever of the fifth embodiment is generally shown at **550** and includes the pivot portion **554** having the circular socket **556** defined therein. The adjustment lever **550** includes several rounded tooth cavities **566** adjacent and grouped with

one another. The tooth cavities **566** extend radially into the circular socket **556** and define an increment of movement of 120 degrees between the groups of the tooth cavities **566**. The tooth cavities **566** cover a setting range between –12 degrees and +21 degrees. The indexing system of the fifth alternative embodiment is generally shown at **570** and includes the hub **574** disposed in the adjustment lever **550**. The hub **574** is independent of and removably invertible relative to the aforementioned adjustment lever **550**. The hub **574** is disposed within the circular socket **556**. The hub **574** includes the outer surface or periphery **576** and an inner surface or socket **580** having a hexagonal configuration for receiving the hexagonal head **48** of the torsion bar **46**. The outer periphery **576** of the hub **574** includes the plurality of teeth **578** adjacent one another and extending outwardly from the outer surface **576** along the entire circumference of the outer surface **576**. The teeth **578** are separated by 120 degrees between the three groups to enable the hub **574** to be positioned angularly with respect to the tooth cavities **566** extending inwardly into the circular socket **556** in any of the number of the selected positions. In this embodiment, the tooth **578** has a rounded configuration to mate with the tooth cavity **566**.

[0041] Figures 11 shows a sixth alternative embodiment of the present invention wherein like reference numerals are offset by **600**. The adjustment lever of the sixth embodiment is generally shown at **650** includes the arm pivot **654** having the socket **656** of a generally circular configuration defined therein and the plurality of tooth cavities **658** defined therein. Each tooth cavity **658** presents a triangular configuration having two sides **660**, **662** interconnected by a rounded bottom **664** with one side **660** sloping at a degree different than the other side **662**. The indexing system of the sixth alternative embodiment is generally shown at **670** and includes the hub **674** disposed in the adjustment

lever **650**. The hub **674** includes an outer surface **676**. The outer surface **676** of the hub **674** includes a plurality of teeth **678** extending radiallly outwardly from the outer surface **676**. One of the teeth **678** presents a triangular configuration complementary to the configuration of tooth cavity. The other teeth **678** includes a rectangular configuration and designed to maintain a constant contact of the hub **674** with the adjustment lever **650**. The inner surface or socket **680** of the hub **674** includes a hexagonal configuration for receiving the hexagonal head **48** of the torsion bar **46**. The sixth embodiment of the present invention provides incremental adjustments in a range from +3 degrees to about +15 degrees.

[0042] While the invention has been described with reference to an exemplary embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.